

January 17, 1861.

Major-General SABINE, R.A., Treasurer and Vice-President,
in the Chair.

The following communication was read:—

“On the Homologies of the Eye and of its Parts in the
Invertebrata.” By J. BRAXTON HICKS, M.D. Lond.,
F.L.S. Communicated by JOHN LUBBOCK, Esq. Re-
ceived December 20, 1860.

(Abstract.)

The author first remarks, that the great similarity which exists in the parts of the eye throughout all classes of the Vertebrata, coupled with the desire to find in the eyes of all animals the same component parts as in that great group, has militated much against a proper understanding of the different parts of the invertebrate eye.

A different method has been followed in the observations upon which the present communication is founded; for, starting from the simplest condition in which the organ appears in the animal series, the necessary elements of a picture-seeing eye are first determined, and afterwards those parts which are superadded to it. A distinction is then drawn between the mere light-seeing eye and that which perceives a picture; the former requiring no lens, the latter having one. The elements of the picture-seeing eye are, in fact,—1st, a nerve-fibre, and bulb; 2ndly, a cell possessing more or less refractive power, and resting on the nerve-bulb; 3rdly, pigment; 4thly, the nerve-sheath, including the other structures. The homologies of these parts are then considered, and traced through the various classes. The cell resting on the nerve-bulb is the homologue of the crystalline lens. It has the power of secreting into its interior a highly refractive substance, which, in the Invertebrata generally, is semifluid, but sometimes, as in certain Insecta, solid. The bilateral tendency of the cell in *Asterias* and in some Entomostraca is pointed out, as also the tendency of the solid lens of insects to split longitudinally into four portions. This is compared with the same condition in the more fluid lens of the decapod crustaceans, and referred

to the mode of development as set forth by Dr. E. Claparède. Moreover, as in many cases these cells become so fused as to form an entirely homogeneous body, the author thinks that the single crystalline lens, possessing many nerve-bulbs (as in mollusks), is formed really by the combination of their various lenses; the pigment in this case being confined to the nerve-bulb, which is its normal position.

It is then pointed out, for the first time, that in some insects, and in *Iulus*, the lens possesses a very slight refractive power, being filled with a fluid as little refractive as water. This is more particularly the case in the *Diptera*, where the dermal facets become so spherical as to usurp the function of the lens, while an example is furnished by the eye of *Aromia moschata* of the complete disappearance of the lens. In opposition to the opinion entertained by many naturalists, the author maintains that each bulb, provided with a refracting body, is capable of perceiving a picture independently of the assistance of other adjoining lenses.

The homology of the nerve-sheath is traced from its condition as a delicate membrane which passes over the simple eye, to that of the sclerotic and cornea; and it is shown to constitute the *true* cornea. After referring to the pigment and iris, the author discusses the parts added to the simple eye. The *anterior chamber*, or the space found anteriorly to the lens and iris (where the latter exists), first appears in the leeches, but is a very variable element in the *Invertebrata*, existing in some aquatic animals, as leeches and cephalous mollusks, while it is absent in others, as *Paludina*, *Limnæa*, &c.; and thus the opinion held by some, that an anterior chamber is of little use in aquatic animals, as in fishes, is scarcely tenable, because they have a compensation in the globular lens. The author has never found an anterior chamber in the compound eyes of the *Insecta*, although a space has been described, and erroneously called a lens. Still the possibility of such a space is not thereby denied; only, should it exist, it would be homologous to the anterior chamber, and not to the lens; and the transparent body behind it is the true lens, and not a vitreous humour, as is often represented. There is such a chamber in the *Decapods*, in which it is well marked. In regard to a chamber posterior to the lens, the author is of opinion that none is to be found below the mollusks, and points out that what

has been so called in the ocelli and stemmata is not the homologue of the vitreous humour, but probably that of the lens, which otherwise is absent in these eyes, for the lens of the ocelli is shown below to be of dermal origin.

The next portion of the paper is occupied in pointing out the part which the integument plays in regard to the optical organs where it passes over them ; and it is shown that in all of the Invertebrata the integument becomes more or less subservient to the functions of those organs. It is in animals with a dermo-skeleton that the greatest subjection of the integument to the eye is seen ; and the change is reviewed *gradatim* from where the eye is independent of the integument, as in *Daphnia*, through *Gammarus*, where the integument is merely applied to it, till, in *Artemia Salina*, we find the inner surface indented, but not yet faceted. In *Branchipus* the *inner* layer only becomes faceted, till in the Decapods both layers become so. But it is in the Insecta that the change is most marked, the form of the facets becoming more or less lens-like, till in Diptera they are nearly perfect spheres. Their power of refraction is very high ; they are supplied with corrections for spherical and chromatic aberration, and they almost altogether supply the place of the true crystalline lens, as before pointed out. The ocelli in Insects and Arachnida show this condition carried to the extreme ; and the author conceives that the so-called crystalline lens of these organs is derived entirely from the integument : this he endeavours to show by reference to their structure and intimate connexion with the other dermal layers, and by tracing them through the various tribes ; and a more complicated structure is described, for the first time, in the median eye of one of the Scorpionidæ (*Buthus*), where the inner integumental layer is converted into a lens more distinct than in any other of the Arachnida. A chamber is also shown to exist in it, formed by the separation of the epidermis from the other layers, producing a plano-convex lens similar in form to the anterior chamber of the higher animals, and analogous to it in function. The stemmata and ocelli, like the facets of the compound eye, have peculiarities in their structure for the correction of spherical and chromatic aberration.

The author concludes by pointing out the striking homology existing throughout the whole animal world in those parts which

were pointed out at the commencement of the paper as forming the essentials of an eye, and considers that it affords a contradiction to the position of Agassiz, "That every great type is formed on a distinct plan,—so peculiar, indeed, that homologies cannot be extended from one type to the other, but are strictly limited to each of them." On the contrary, the eye of an *Asterias* is formed on the same plan as that of a *Planaria* and a *Daphnia*; and the eye of the leech possesses the same parts as that of the *Helix*, while the similarity of the eye of the cephalopod to that of the vertebrata is obvious to all.

January 24, 1861.

Major-General SABINE, R.A., Treasurer and Vice-President,
in the Chair.

The following communications were read:—

- I. "On the Calculus of Symbols, with Applications to the Theory of Differential Equations." By W. H. A. RUSSELL, A.B. Communicated by ARTHUR CAYLEY, Esq. Received December 20, 1860.

(Abstract.)

The calculus of generating functions, discovered by Laplace, was, as is well known, highly instrumental in calling the attention of mathematicians to the analogy which exists between differentials and powers. This analogy was perceived at length to involve an essential identity, and several analysts devoted themselves to the improvement of the new methods of calculation which were thus called into existence. For a long time the modes of combination assumed to exist between different classes of symbols were those of ordinary algebra; and this sufficed for investigations respecting functions of differential coefficients and constants, and consequently for the integration of linear differential equations, with constant coefficients. The laws of combination of ordinary algebraical symbols may be divided into the commutative and distributive laws; and the number of symbols in the higher branches of mathematics, which are commutative with respect to one another, is very small. It became